Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	ET Docket No. 03-104
	)	
Inquiry Regarding Carrier Current Systems, including Broadband over Power Line Systems	)	

The following comments are those of myself, Roger V. Thompson, an Extra Class amateur radio operator (AD5T), licensed Professional Engineer and retired wireless research manager having over 30 years experience in radio as a profession and a hobby. I am the owner of a telephone company[1] that provides DSL broadband services in a rural area of Mississippi and operator of an Internet Service Provider[2]. Because of my background in professional wireless research, amateur radio and provision of broadband Internet services, I have a unique perspective on the matters considered in this inquiry. Thank you for the opportunity to comment on this important matter.

The tone of this NOI is that the Commission has decided that Broadband over Power Line (BPL) is to be promoted and encouraged, perhaps by changes in the Part 15 rules that exist today. A more relevant question is if BPL is deployed, regardless of compliance with present Part 15 rules, might it cause significant interference to licensed services? It is discouraging to me that the Commission would state support for a technology apparently without adequate investigation into its impacts on licensed users of radio spectrum.

I first address some issues of broadband deployment and, later, issues about the radio interference from the proposed Broadband over Power Line (BPL) services.

The Introduction to this Notice of Inquiry states that "BPL could bring broadband access to rural and underserved areas, which often are difficult to serve due to the high costs associated with upgrading existing infrastructure and interconnecting communications nodes with new technologies." As a provider of rural broadband service, I would prefer to not have more competition, but I do have two comments on this statement: First, there is nothing to suggest that BPL will not be subject to the same high costs if the technology is deployed in rural areas as the driving function for cost recovery and eventual profitability is inexorably tied to the density of paying customers. Deploying the necessary electronics and support infrastructure in rural areas to serve a scattered number of customers will very likely have similar costs and requirements as does, for example, DSL. In fact, the largest issues regarding broadband access in rural areas are not technology related, but are the high cost of obtaining connectivity to the Internet backbone and the costs of operations, administration, maintenance and provisioning. Secondly, there is a misunderstanding about the availability of broadband services in rural areas because the FCC does not request information about deployments of less than several hundred broadband users for a single company, so deployments like that for my company are never reported and the availability of rural broadband access is generally understood to be less than it actually is.

My comments regarding radio issues are primarily contained in the following answers to questions posed in this Notice:

[1] The Smithville Telephone Company, Inc.
[2] Traceroad.net

In order to transfer high frequency signals beyond the low-voltage distribution transformer, Access BPL systems use high-pass filter circuits to bypass the transformer and its inherent low-bandwidth characteristics. What is the effect of these high-pass filters with respect to high-frequency signals used inside the house, *e.g.*, from In-House BPL equipment or other in-premises technologies, that may rely on the low-voltage transformer as a natural barrier to avoid causing interference at higher frequencies?

As transformers are bypassed for high frequencies, the isolation that exists today will disappear, exposing BPL data customers and non-subscribers alike to noise and signals from other homes or businesses, broadcast radio sources, radiating electrical equipment, arc welders, computer radiation, and other noises carried on the power line. Sources of interference that were reduced in amplitude by the transformer isolation at high frequencies will become more apparent. This increase in interference and noise will impact innocent bystanders on the same transformer who have no interest in using broadband power line data services. Exposing the uncontrolled home and business environment to the power distribution grid at high frequencies also increases the possibility of significant non-linear effects that can cause mixing of the desired data signal frequencies and generation of harmonic and non-harmonic products that can cause unexpected effects at frequencies outside the transmitted bandwidth. Systems deployed for years to implement control and alarm purposes in homes that depend on transformer isolation will be exposed to the possibility of false operation and there may be more damage from the higher frequency components of lightning strokes that would have been reduced by the unmodified transformers.

Obviously, same-transformer users of the same spectrum as used by Access BPL inside the house will be adversely impacted even if they are not users of BPL services. This impact will also exist for high frequency services like standard time stations (WWV and CHU in North America) and short wave broadcast listeners. Additionally, even if the local transformer is not bypassed, Access BPL signals on the medium voltage side of the transformer will very likely cause similar impacts. The interference footprint of Access BPL will be much larger than the locations of served customers.

Is there a need to define frequency bands that must be avoided in order to protect the licensed users on the same frequencies as those used by Access BPL systems?

Certainly, the answer to this is yes, but the Commission resolved this issue in a previous Report and Order (FCC 03-105), where the decision was: "We note the significant potential for interference between the proposed amateur operations and the incumbent PLCs. ARRL concedes that amateur operations and power lines with attached PLCs would have to be separated in order to prevent interference. We find that separation distances on the order of 950 meters would be necessary to protect the PLCs from interference. We also find that this distance, coupled with the larger-than-expected number of PLCs potentially impacted by this proposed allocation, increases the likelihood that a PLC-equipped power line will be close enough to an amateur station to receive interference." The result of this conclusion was to deny access to the PLC frequency range for amateur stations as there was no immediately available way to share use of the spectrum.

This order addressed existing PLCs at low frequency, not in the high frequency range, and a particular type of power line, but the fundamental principles of radio remain the same over frequency and the much higher amateur radio power, sensitive receivers, and more efficient amateur and power line antennas at high frequencies can only make bilateral interference more of a problem as the frequency is raised. Access BPL is not at all compatible with spectrum used by licensed entities.

Are there mitigation techniques Access BPL systems can use to avoid possible interference with licensed users of the spectrum, such as mobile users or public safety and law enforcement users who may be traveling directly under the medium voltage lines?

"Listen before talk" type avoidance protocols will not work to reduce interference because licensed communications users both transmit and receive and may be in a receive mode at an interference location.

Reception of distant transmitters can be impaired by local power line interference as there is no way for the power line BPL system to independently locate non-transmitting mobile or fixed licensed stations. Even at frequencies outside the nominal range of BPL frequencies, harmonic radiation and mixing products may possibly impair public safety, law enforcement and other spectrum users. Mobile and fixed amateur radio operations are often impaired today by radiation from power lines and cable television systems.

The bands assigned to licensed users should be excluded from use in an Access BPL system. In addition, emissions from harmonic and mixing products that might fall within licensed spectrum must be limited.

Since Access BPL equipment is installed on medium voltage lines that supply electricity to a residential neighborhood, should this equipment be treated as operating in a residential (Class B) or commercial (Class A) environment?

Stringent restrictions on interfering radiation from Access BPL should be implemented, but it is not clear to me that the current classes are sufficiently restrictive as they did not envision distributed interference sources that could extend for miles.

How does the close proximity of Access BPL equipment to cable television and telecommunications equipment from third party service providers co-located on the same utility pole affect the operation of these services? On the other hand, what is the effect of this close proximity to Access BPL operations?

This Notice does not provide sufficient information about the technical characteristics of Access BPL to address this question; however a practical answer is that both theoretical analysis and measurements would be required to develop a proper response.

What are the probable interference environments and propagation patterns of Access BPL and In-House BPL systems? Are there specific issues of interference that we should address, *e.g.* an increase in the level of the noise floor? What models are available for predicting radiated emissions from access BPL systems?

To better understand the far field radiation and reception capabilities of power lines, I modeled the power line serving my farm, which I believe to be fairly typical of rural areas, at three frequencies. This line is a vertically separated single phase line with a length of about 1800 feet from the main roadway to the transformer at my property. EZNEC[3] was used to approximate this antenna assuming real ground of medium conductivity and aluminum conductors. The results are shown in the following table:

Frequency (MHz)	Gain (dBi)	Elevation Angle (Degrees)
3.5	-3.7	20
5.3	-7.0	24
6.5	-1.31	14

In all three cases, multiple higher angle lobes exist and are only down a few dB from the main lobe, with the difference increasing with frequency as would be expected for an antenna as it gets longer in terms of wavelength. While the EZNEC version I have does not permit accurate higher frequency analysis for such a large radiator, it is a certainty that this power line antenna will have positive gain at low elevation angles as the frequency increases to the higher HF range.

Is this a reasonable power line to model as an antenna? Yes, because power lines extend for miles along roadways in linear fashion and the limit for antenna length is the maximum repeater spacing for the data transmission equipment, which I believe is expected to be thousands of feet. As these data lines are built,

[3] EZNECv.3.0.16 By Roy W. Lewallen

repeater sections and the associated power line antennas will form a distributed linear array antenna that will increase the radiated power over that of a single section. Neighborhood distribution of data signals is more difficult to model, but will have similar radiation characteristics because wires supported well above ground make excellent antennas. Full scale test implementations of data systems on typical types of power lines are necessary to fully understand the interference characteristics of these proposed broadband systems.

Access BPL transmitters using antennas of these sorts at higher frequencies will likely cause an increase in noise and interference hundreds and thousands of miles away from the source due to skywave propagation, especially at the peak of the solar cycle. At the lower frequencies modeled above, near incident vertical skywave (NVIS) antennas are typically used for high frequency links out to several hundred miles and the higher elevation lobes of the power line antenna will splash noise over thousands of square miles. Almost all of the state and regional amateur radio traffic and emergency nets operate in this lower HF frequency range. While amateur radio operations, even potentially including those involving safety of life and property, would be impaired, so likely would military communications.

Inexperienced persons might be skeptical that such low radiated power could travel so far, but examples of this sort of propagation can be found in the July, 2003 issue of the "Lowdown[4]," which covers the activities of experimental communications using Part 15 compliant transmitters. A signal at 15.5555 MHz from North Carolina was received in Norway, a signal from Maine was received in Western Canada, one from Florida was received in Maryland, and there are other similar reports. In 5 to 7 years, the solar cycle will peak and enhance long distance high frequency propagation greatly in comparison to the relatively poor conditions today.

Are the existing Part 15 rules for low speed carrier current systems adequate to protect authorized users of the spectrum who may be affected by the new high speed BPL technology? What changes to these rules, if any, are necessary to protect authorized radio services?

High speed BPL should not use the licensed spectrum assigned to authorized radio services. Proposing simultaneous uncoordinated use of spectrum for different services is analogous to using one highway lane for two-way vehicular traffic.

Is there need to specify different limits for Access and In-House systems? For example, would it be appropriate to allow higher emissions for In-House systems where the user would be the principal party affected by interference, and could take steps to mitigate the interference, than for Access systems where the interference would affect a wider area and therefore be more problematic to mitigate? Would higher emissions for In-House systems result in any interference effects in other houses or apartments sharing the same local low voltage distribution by the RF signal being distributed on the low voltage side of the transformer? What limits should be specified, given the above considerations?

Interference from other residences on the same transformer is a well known and growing problem to amateur radio operators today, so the premise that the user of the equipment would be the primary one impacted is not correct. In fact, the user will likely be completely unaffected by the interference. One clear example is the harmonic radiation from television sweep oscillators and there are as many more as there are devices that radiate energy in the high frequency or VHF ranges. If interference from other residences were not a problem, then "house codes" would not be necessary on the common control systems that have been available for years. Given this situation, increasing the interference by allowing high level emissions from In-House systems is unwarranted. It is a good question if the systems should be allowed at all if they radiate in licensed spectrum likely to be used in close proximity.

It is difficult to impossible to get neighbors to take corrective action to reduce interference caused by devices they have purchased and used under the assumption the devices were completely "legal" to use as advertised.

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[4] "The Lowdown," A Publication of the Longwave Club of America, 45 Wildflower Road, Levittown, PA 19057-3209

In many situations, it is impossible to even identify the sources of interference. This is a major failing of the entire premise of Part 15.

Combination of In-House and Access BPL systems will obviously impact the interfered environment adversely by expanding the scope of interference past the low voltage transformer. Since there is no control of deployments of In-House systems, any regulation should assume they are in combination with Access BPL.

Would the new high speed Access and In-House BPL equipment pose a higher risk of interference to licensed radio services that the traditional carrier current systems?

The background discussion preceding this question states, "the low speed systems have not been a source of harmful interference to radio communications." My understanding from reports in the amateur radio literature is that this is incorrect as there have been instances of interference from these devices[5], and this causes me to wonder if the Commission is not correctly informed regards the practical effectiveness of their present Part 15 rules in reducing interference. In any case, since the high speed access and In-House systems use or propose to use the same spectrum assigned to licensed users there obviously will be a higher risk of interference.

In closing, I have to comment that no reasonable telecommunications engineer would freely recommend using power lines for communications of the sort envisioned in this order. As transmission lines designed for the power frequency, they are spaced much too widely for efficient use at the higher frequencies needed to support useful data communications. Even the open wire transmission lines used for telephone voice transmission in the past were more closely spaced, but these antique systems have been replaced by other cable structures that can easily support high frequency transmission for thousands of feet. With only a few conductor paths, and only one for a good portion of the power distribution grid, the capacity of the BPL system is limited in comparison to other alternatives that are already deployed. Certainly, the security of this sort of system is questionable and the possibility of unauthorized access and use is large given that the transmission medium will appear in many homes and businesses without invitation or a business relationship with the BPL system operator.

Since the unfortunate events of September 11, 2001, many licensed radio amateurs, including myself, have become more committed to supporting emergency communications and have strived to become more educated and professional in preparing for communications emergencies we hope will never come. It can not be in the public interest for the FCC to enable a redundant broadband service with limited capabilities that will increase interference to licensed services and significantly impair or destroy irreplaceable high frequency radio communications capabilities in the United States.

Roger V. Thompson
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[5] Phonex PX-421 wireless modem jack, see http://www.arrl.org/tis/info/rfiteljx.html for a discussion.